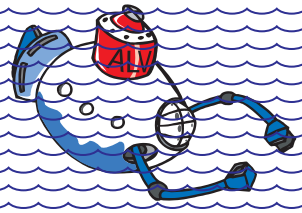

Thar She Blows!

Focus
Hydrothermal vents

Grade Level
9-12

Focus Question
How does the proximity of hot magma to cold ocean water create new rocky structures around hydrothermal vents?

Learning Objectives
Students will demonstrate an understanding of how the processes that result in the formation of hydrothermal vents create new ocean floor.

Students will demonstrate an understanding of how the transfer of energy affects solids and liquids.

Additional Information for Teachers of Deaf Students
The words listed as key words should be introduced prior to the activity. There are no formal signs in American Sign Language for any of these words and many are difficult to lip-read. If some of this information has not already been covered in your class, you may need to add an additional class period to teach vocabulary and teach some of the background information to the students prior to the activity. The activity itself is very visual and is easily followed by most deaf students. A formal lab report of all of their observations is an excellent additional assessment tool.

Materials
- ❒ 1 16 oz. container of paraffin wax
- ❒ Ice
- ❒ 10 thermometers
- ❒ 10 one-liter beakers
- ❒ 10 hot plates or other heating device
- ❒ 10 aluminum pie pans
- ❒ Oven mitts

Teaching Time
One 45-minute period

Seating Arrangement
Groups of 3

Maximum Number of Students
30 students

Key Words
Hydrothermal vent
Magma
Mantle
Crust
Precipitation
Rift
Geysers
Dense
Transferred energy

Background Information
Rifts and hydrothermal vents offer a real life example of how transfer of energy affects solids and liquids. Rifts occur on the ocean floor where drifting continental plates are separating. The rift, the area in the crust where the plates separate, creates an opening in the crust where the cold water of the deep ocean is

exposed to the Earth's mantle. The mantle, with an average temperature of 1000 degrees Celsius, consists primarily of molten rock and minerals. When the continental plates separate, the magma of the mantle rises to fill the gap in the crust. When this molten rock comes in contact with the cold ocean water (near 2 degrees Celsius), the energy of the magma is transferred to the water, the magma lowers in temperature, and the minerals in the magma form bonds that create new solid rock sea floor crust.

Hydrothermal vents are underwater geysers that are found on the new oceanic crust formed by the rifts in the ocean floor. The thin, new ocean crust has cracks in it through which ocean water can seep down to the hotter mantle below. As the ocean water comes in contact with the magma of the mantle, the energy of the magma is transferred to the water, which becomes superheated. The heated water molecules are less dense than the cool ocean water, and will begin to rise. The underground water also dissolves minerals from the surrounding magma and rock. As the water rises, it carries the minerals from the magma with it. When the heated minerals come in contact with cooler water again, the energy from them is transferred out and the minerals precipitate and settle to the ocean floor. As the minerals settle they form structures that resemble chimneys with the hydrothermal vent geyser in the middle. Thus, the transfer of energy between magma and water creates new ocean floor structures.

Learning Procedure

Preparation:

1. Cut paraffin wax into 10 equal-sized blocks, about 25g each.

Classroom Activity:

1. Discuss with your students the geologic processes that create mid-oceanic rifts and hydrothermal vents. Ask the students the question, "How does the proximity of hot magma to cold ocean water create new rocky structures on the deep sea floor?"
2. Divide the class into teams of three students each. In each team, one student will be the manipulator of materials (wax, ice, hot plate), one student will use and read the thermometer, and one student will record observations and thermometer measurements.
3. Each team will receive a one-liter beaker filled with 500ml of water, which they will try to make as cold as the deep ocean water (about 2 degrees Celsius) by adding ice. Students will both measure the temperature and make observations of the water, and record their findings.
4. Each team will receive 250ml of ice. Students will both measure the temperature and make observations of the physical properties of the ice, and record their findings.
5. Have students place thermometer in the water and leave it there. Have the students place the ice in the water and observe for three minutes. Have them record what happens to the temperature of the water during this time and what happens to the physical properties of the

ice.

6. Discuss with the students what happened with the ice and water and relate this to transfer of energy.
7. Give students a block of wax. Have them observe and record the physical properties of the wax.
8. Have students use the point of a pencil to bore a small hole in the wax. Have them place the end of the thermometer in the hole and measure and record the temperature of the wax.
9. Give each team a hot plate and an aluminum pie pan. Have students turn the hot plate on to medium heat and place the wax block in the pan. Have students hold the thermometer in the hole in the wax and observe what happens to the temperature.
10. When the wax has completely melted, have them measure the final temperature of the wax and observe the physical properties of the wax and record measurements and observations. Have students wash thermometer under hot water to remove wax before moving to the next step.
11. Have students take another temperature reading of the water and record their measurement. Have the students leave the thermometer in the water and carefully pour the wax into the water. Have students measure what happens to the temperature of the water after the wax is added in 30-second increments for 2 minutes, as well as observe and record the changes that happen to the physical properties of the liquid wax.
12. Discuss with the students their observations. What happens to a solid when energy is transferred to it? What happens to a liquid when energy is transferred away from it? Based on what they have observed, what do they think happens when hot magma comes in contact with cold ocean water around hydrothermal vents and rifts? Have them conduct research to see if their predictions are correct.

The Bridge Connection

http://www.vims.edu/bridge/vents.html

Go to this site for a BRIDGE Ocean AdVENTure on hydrothermal vents and other informative web links.

The "Me" Connection

Have students think of things they use every day that are made of iron, copper, and nickel and how some of these may be important to their diet. Discuss with students how metals such as iron, copper, and nickel are abundant in the Earth's mantle and how they often rise at rifts to form new oceanic crust. Discuss with the students whether they think the new crust around hydrothermal vents is important because it contains these metals.

Connections to Other Subjects

Geology, Chemistry

Evaluation

Have students write a log entry with illustrations that describes how the energy transfer at rifts in the oceanic crust creates new rock structures on the deep sea floor.

Extensions

Have your students visit http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu with a member of their family each day to keep up to date with the latest Galapagos Rift Expedition discoveries.

Science - Have students conduct research to compare and contrast volcanoes and geysers with oceanic hydrothermal vents and rifts.

Language Arts - Have students write an article for a newspaper that explains the importance of hydrothermal vents to an audience that may never have heard of hydrothermal vents before. The article should be written using terms that audience can easily understand.

Resources

http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu -
Follow the Galapagos Rift Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of resource information can also be found at both of these sites.

www.onr.navy.mil/focus/ocean/habitats/vents1.htm
Information on life and physical science of hydrothermal vents

www.amnh.org/nationalcenter/expeditions/blacksmokers/black_smokers.html
Information on characteristic features of hydrothermal vent areas

www.divediscover.whoi.edu/about.html
Information on scientific expeditions to hydrothermal vents

www.seismo.unr.edu/ftp/pub/louie/class/100/interior.html
Information and graphics on the science of Earth's interior

Van Dover, Cindy Lee. *The Octopus's Garden*, Addison Wesley Longman, Inc. 1995.
Information on science and exploration of hydrothermal vents

National Science Education Standards

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard B: Physical Science

- Interactions of energy and matter

Activity developed by Kevin Kurtz, South Carolina Aquarium

Student Data Sheet

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Initial temperature of the ice water:

Temperatures of water after the hot wax is added:

30 seconds:

60 seconds:

90 seconds:

120 seconds:

Observations of the physical properties of the wax:

Temperature of the wax:

Physical properties of the wax:

Observations of changes in temperature and physical properties when wax is heated:

Final temperature of the heated wax:

Observations of changes in temperature and physical properties when water and ice are combined:

Temperature of the ice:

Physical properties of the ice:

Temperature of the water:

Physical properties of the water: